TESSELLATE communication

STEM Professionals in Schools

2018-19 program impact evaluation

CSIRO

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ACKNOWLEDGEMENT:

Tessellate Communication Pty Ltd would like to acknowledge and thank the school Board, Principal, teachers and students for their willingness and time taken to participate in the case study and share their views and experiences. We also appreciate the hospitality and support extended during our site visit.

Thank you also to the STEM professional for the time taken to participate in the case study and similarly, for sharing your views and experiences.

We also acknowledge and thank CSIRO's Human Research Ethics Committee and for providing ethics approval to undertake this study as a component of the STEM Professionals in Schools program – 2018-19 impact evaluation.

The findings from the case study will inform and enhance the final evaluation report.

Note

This is the final case study report for a partnership within the STEM Professionals in School Program. This case study was one of four purposefully chosen case studies within the 2018-19 impact evaluation which collectively provide insights into important aspects of the program. This case was selected as it includes:

- Female teacher partner
- Independent secondary school
- Regional location
- STEM professional from large industry partner.

Disclaimer

The case study findings presented in this report have been determined by Tessellate Communication Pty Ltd, drawing on the data collected from case study participants based on their views and experiences in the selected program partnership. Participants have reviewed a draft version of this report and any feedback provided has been incorporated in this final version of the report.

Table of Contents

Table of Figures

1 Extra-curricular robotics program

This case study explores the impact of the CSIRO STEM Professionals in Schools program in an independent senior, co-educational school in South Australia. It includes the experiences and thoughts of the teacher, students and STEM professional involved in the partnership and the Principal of the school. The partnership includes the conduct of an extra—curricular robotics program run within school.

The case study occurred from June to December 2019. This included an initial site visit during which interviews with the teacher and Principal, and an online survey with nine students participating in the program were conducted. A subsequent interview with the STEM professional was conducted via telephone. Data analysis and case findings were reviewed by CSIRO program representatives, the teacher and STEM professional partners and the school Principal prior to the final report.

Overall, the program partnership was viewed as very positive and worthwhile, generating unanticipated benefits such as helping students with dyslexia and developing important life and social skills. Outcomes were noted in all participant groups as well as within the school and the broader community due to the national and international success from the school's robotics program. Recommendations were made to address challenges and take advantage of opportunities in the areas of knowledge sharing, improving sustainability, and consolidating government and sector support for STEM.

These are detailed further in the following sections highlighting the:

- challenge
- process
- outcomes
- learnings.

1.1 The challenge

Over time, the evolution of computer literacy in schools to meet curriculum requirements has shifted from teachers requiring local application knowledge, to coding and software engineering:

> *This is an extremely challenging leap. (2019, Teacher, SA)*

The school has anticipated and prepared for this:

> *… enabling us to maintain a high standard in this area. (2019, Teacher, SA)*

The partnership has been an essential element in sustaining STEM in the school, as the few teachers who had the more advanced skillset were already committed to other programs.

Although the school is very supportive of the partnership and the Principal recognises that the teacher has the qualities of commitment, passion and technical talent to successfully drive the extracurricular robotics program (i.e. the product of the partnership) forward.

1.2 The process

To address the changing curriculum requirements, the school partnership focuses on technical engineering, specifically an extra-curricular robotics program that is run throughout the year, highlighted by annual participation in Science Alive, an interactive South Australian based exhibition the week prior to Science Week, and the [competition name redacted], an international high school robotics competition.

The extra-curricular activity is open to students in secondary-school years. The Year 12 students lessen their involvement to concentrate on studies, which creates a steady transition for the younger years.

The partnership consists of a teacher who leads robotics, maths and multimedia teaching for levels 11-12 and a STEM professional, previously involved with the school in a mentoring capacity. The STEM professional, who has been involved since 2017, is a technical specialist in communication networks for the [organisational name redacted]. He volunteers his own time after work a couple of hours/week during school term and occasionally on weekends. Although his employer has a STEM support program, it is only extended to university students and thus he does not receive any direct support from his employer to support his involvement.

The school has customised the teacher's role to accommodate the partnership through granting her a position of responsibility, which modifies her contact with students in a curriculum teaching capacity. This enables her to assign time and workload to the extra-curricular program.

The STEM professional's involvement with the program originated when his son, who was in the robotics team, requested his assistance following the departure of the one and only student programmer within the team. Once his son graduated, the STEM professional remained with the program due to his robust relationship with the teacher:

> *She is extremely dedicated and has created an incredibly engaging programme which has a multitude of positive student outcomes. (2019, STEM professional, SA)*

The STEM professional assists the teacher in the robotics program throughout the year, including helping manage the interactive engineering components of the Science Alive exhibit. However, he is primarily involved in supporting the senior students in the [name redacted] competition by providing programming training, brainstorming and mentoring during competitions. He also referees other robotics competitions for a different age group.

In-between the competition, the partnership also supports the annual student exhibition showcasing robotics at Science Alive, which is a 3-day expo a week prior to Science Week. The school's exhibit, developed and run by the students has become one of the largest and most popular incorporating an interactive engineering challenge:

> *They engage with the public and younger children which builds their confidence and teaches them to create something with an end-user in mind. (2019, Teacher, SA)*

The STEM professional also helps the students build robots, which act as waiters, to showcase at school fundraising dinners, working collaboratively with students from other classes such as food technology.

The Principal would like to expand the program for the students to progress from using kit-based applications to design, testing and manufacturing of components. They are also aiming to achieve this through expanding industry relationships. From an overarching perspective, the school is looking to overcome the limitations of including STEM in an already crowded curriculum by trying to integrate STEM in all the classes rather than viewing as a separate component.

The school communicates about the partnership through its website, Facebook, Instagram, internal messenger group, Open Day demonstrations, School Council meetings and at Foundation fundraising events. Industry participation was promoted through the STEM professional who invited his work colleagues to attend.

1.3 The outcomes

The program is viewed very positively by the Principal as developing linkages to the world beyond the *"four walls of the school buildings"*, supporting the school's goal to provide as many options to the students as possible. It meets this aim by:

> *… opening up their world to realise they don't have to settle – they can live and work anywhere by generating awareness of the variety of non-traditional STEM roles available across diverse sectors from engineering to manufacturing. (2019, Principal, SA)*

The [competition name redacted] is a major international event billed as ‘Sports for the Mind’, whereby teams of high school students are challenged to raise funds, design a "brand," hone teamwork skills and build and program industrial-size robots to play challenging field games against competitors over a series of qualifying events across six weeks. In addition to on-field competition, teams and individuals compete for awards recognising entrepreneurship, creativity, engineering, industrial design, safety, controls, media and quality, and exemplifying the core collaborative values of the event.

A third of the competition involves creating the robot, while the remaining two thirds require maintaining an engineering journal, researching the project and application of teamwork to strategically solve the challenge. The event stresses the traits of fairness and sharing through randomly mixing groups into alliances to compete against other alliances:

> *These skills are extremely hard to teach except by doing and by example. The students experience the outcomes of their behaviour in an accelerated environment similar to a real workplace. (2019, STEM professional, SA)*

> *They have to think on their feet quickly, to come up with a technical solution that is real world, which generates a lot of self-reliance and confidence. (2019, Principal, SA)*

The competition involves global exchanges and as the school was one of the first, their role now requires mentoring newcomer teams across Australia and the South Pacific. This includes a female student who applies international liaison skills in the role of ambassador, while another is working with a political advisor to incorporate the robotics competition into Federal Government grants currently only offered to traditional sport activities.

The program events, especially [competition name redacted], act as an engagement platform to teach students the application of STEM and the ability to collaborate, manage, coordinate and negotiate within a workplace environment. Theory is converted to practice which builds STEM capabilities while also generating transferrable skills:

> *One student who had never built a program and struggled with dyslexia went from zero to hero in about a month - absolutely excelling. (2019, STEM professional, SA)*

Although the Principal recognised the benefits of the students winning the national and the world championship including the resulting profile raising and accolades brought to the school, he viewed the biggest value as student collaboration, mentorship, life skills and problem-solving. The program helps kids who are introverted, generating confidence by having to perform in front of local to global audiences in their thousands:

> *The cheering and sense of pressure on the competitors in these huge stadiums is similar to the energy at a football game. (2019, STEM professional, SA)*

The competition is structured to provide authentic professional exposure to the students. Developing resilience and commitment is created by facing consequences of missed deadlines, learning about failure and that adults don’t always have the answers:

> *Having to successfully present to a stadium full of peers challenges them to avoid the quickest and easiest path, which previously may have seen them rely on others to do the work or bail them out. (2019, Teacher, SA)*

Robotics provides a meaningful alternative to the prevalent pastime of gaming. The group is regarded by many of the students as a family - a safe and secure place to spend time with others:

> *… who think like them. (2019, Teacher, SA)*

It also enables them to pursue and develop competitive skills out of the traditional sporting arena, which most of these students don’t resonate with.

The STEM professional's creativity was viewed as highly beneficial combined with a very collaborative approach and excellent ability to guide and teach the students by:

> *… determining their goals, breaking down the elements and developing a scaffolding process to help them get there. (2019, Teacher, SA)*

He adapts the process to best suit the project and optimise the student's potential utilising one on one interaction, to small groups or in-depth training programs for the more senior and gifted students:

> *He flows with the team. His agenda is 'what's the best way of doing this?', adopting high level thinking while always looking at how he can push them a little bit further. (2019, Teacher, SA)]*

Several students would not be involved in engineering if the program did not exist.

The teacher wanted to retain the STEM Professionals in Schools program and see it expanded within their school and across others:

> *I like to think that this program is available to other people and that because we are doing it and we are having success, that will lead to more people coming onboard. (2019, Teacher, SA)*

However, the STEM professional observed that the success lies primarily through involvement in the [competition name redacted] competition which is a comprehensive and highly structured program:

> *It has clear goals and expectations and is well supported. (2019, STEM professional, SA)*

The STEM professional indicated that he would be involved with the school regardless of CSIRO's involvement whose value add was facilitating the working with kids and police check requirements.

1.4 The learnings

There were a range of learnings that have been gleaned from this successful long-term partnership. These are highlighted in the following sections:

- Knowledge sharing
- Partnership sustainability
- Program sustainability and competition
- Sector leadership and resourcing.

Knowledge Sharing

The introductory sessions with CSIRO showcased the program resources to support teacher participation, however, the teacher felt substantial opportunities existed to improve knowledge sharing. Furthermore, although CSIRO frequently requests updates, feedback isn't provided to teachers which impedes their ability to learn from others.

Teacher peer collaboration and mentorship is a beneficial approach:

> *I go in and show other teachers what a lesson looks like according to their needs, so I can say 'ok, what if we add this' and then they can see that just adding that one element creates significantly improved outcomes, but I can't be in every classroom. (2019, Teacher, SA)*

Greater self-sufficiency could be generated by a teach the teacher model involving an intensive training partnership with STEM professionals. The system would combine scientific activities and processes (e.g. problem solving, research methodology), for application across all subjects, enabling the teachers to exclusively undertake student engagement:

> *… so, you are still receiving that professional knowledge and the professional insight, but you are not putting the professionals in front of five, six or seven-year olds. (2019, Teacher, SA)*

Using a simple online newsletter format on the CSIRO site which provides concrete examples of program participation across schools, including describing activities targeting each student level, would be an immediate contribution to closing the knowledge sharing gap.

Partnership sustainability

The Principal expressed concern regarding the key person dependency of the partnership, having been unable to identify and train another staff member to support the teacher and to ensure succession planning.

> *… a conscious worry that I have that if [teacher's name redacted] won a position somewhere … she's highly employable … It is a struggle to find that right person to work with [teacher's name redacted] and the kids, who has that knowledge, and is able to bring that knowledge, or is willing to be trained to work with [teacher's name redacted]. (2019, Principal, SA)*

Although the teacher's relationship with her STEM professional is excellent, differences in work and school schedules sometimes proved challenging, especially as the STEM professional is not allocated any time by his employer. The teacher also noted that her colleagues had experienced challenging partnerships with STEM professionals who were not a good fit, uncertain about how to create a session and lacked teaching skills.

The Principal acknowledged that applying a more in-depth criteria to initiating the pairing process, combined with ongoing management, would reduce program risk. Nurturing the partnership through regular monitoring, reviewing resource requirements, addressing priorities and potential issues, would fundamentally positively shift the program.

As pairing compatibility is central to the program's success, creating a bank of STEM professionals with defined skills and experience aligned to student levels, who can be booked for a period of time, was presented as an opportunity:

> *Borrowing a professional for three to four weeks would be wonderful. You know they have a program they are confident to present at the right levels. (2019, Teacher, SA)*

Building a pool of STEM professionals requires a strategic approach and awareness of recruitment opportunities:

> *When we had the robotics tournament last year, our STEM professional recruited seven or eight judges for us from his workplace because they wanted to see what he was doing and see what was happening, which created the next pool for more schools to be involved. (2019, Teacher, SA)*

Program sustainability and competition

Additionally, there was a feeling that the broader [CSIRO] program requires more promotion to generate program awareness and understanding:

> *Teachers and professionals don't know that it exists or remain unclear how to use it. They don't know where to start. (2019, STEM professional, SA)*

A multitude of STEM focused programs creates competition for funding and minimises the attention to a comprehensive, well structured, outcomes driven product. Balancing the program requires providing enough information, while generating engagement with key stakeholders i.e. teachers, STEM professionals, students, schools and industry.

> *You have got people really wanting to do things but without some support they won't know how to start. (2019, Teacher, SA)*

A variety of models and structures were recommended to enhance program delivery.

A past program called "Murder Under a Microscope," which integrated STEM across five to six subjects and remains applicable to the current curriculum, was viewed by the teacher as extremely successful. Originally implemented by teachers, but adaptable to STEM professionals, the program's competition component was regarded as very secondary to the student discussions and learnings generated within a comprehensive, engaging format. The program also underscored the importance of teamwork:

> *You could have kids researching a section and the whole class was reliant on your research because it might be your section that ended up as the critical one, so everyone had to continuously do their part otherwise you were letting your team down. (2019, Teacher, SA)*

"Murder Under the Microscope" was well resourced and its flexibility supported the teachers' time and workload demand:

> *That sort of program was fabulous, and you could engage in it for as many minutes a week as you wanted. It could be just an after lunch for 5 minutes or you could spend a whole lesson on it. It was very flexible but really outcomes driven. You could get professionals in for that sort of thing. (2019, Teacher, SA)*

A tender process could consolidate and unify the multitude of different interest groups creating STEM programs and competing for the same funding:

> *The current system is so inefficient. Here's the government's bucket of money, write a grant, get the bucket of money, you've got two years to work on this. After about six months of doing the work you've got to start writing the grant to get more money to come back. [2019, Teacher, SA)*

Skoodle, a digital resource program for school teachers, was discussed as a successful tender example:

> *Just fund the things properly in the first place or let's look at what teachers need and let's actually make that available to them and we'll say ok this is a tender. (2019, Teacher, SA)*

Placing all the programs in a central location for teachers to identify the best fit would be impactful.

Government and sector leadership support and resources

A cultural shift requires raising the perceived value of STEM held by schools and government to equal that of sports, which would lead to adequate funding, operational resources and management. Expanding the program across more classrooms and targeting more year levels would be another beneficial outcome.

Highlighted also was the importance of normalising STEM student involvement from a kindergarten level:

> *In the early years up to late primary a lot of girls are involved until they move to high school and peer group pressure gets them. (2019, STEM professional, SA)*

The school has made use of alternate funding to acquire additional tools that assist the partnership, such as the acquisition and use of a 3-D printer to design and create unique custom parts for the robots, developing and enhancing student skills in these areas. It was noted however that funding from government sources can be hard to acquire due to the lack of recognition of the competition as a 'sport'. According to the STEM professional:

> *… there is still a bit of a stigma that sport is more exciting than academics and STEM … we are not there yet in terms of providing the same recognition of STEM as is done in personal and team-based sport. (2019, STEM professional, SA)*

Providing a small budget for resources to overcome the STEM professional covering extra costs would be beneficial. The android phones which are used to control the robots are not always supported by the school's IT Infrastructure. Although the STEM professional helped address these roadblocks, the ability to access funding to support the partnership was seen to be an enhancement that could be made to the program.

> *… biggest barrier faced daily is the IT infrastructure. Programming uses android phones to control the robot. That requires you to connect to internet resources and the IT infrastructure tends to get in the way. It can also be expensive … doesn't have to be a full kit but around $1000. (2019, STEM professional, SA)*

1.5 Student survey

About the students

Nine students completed the case study student survey – three girls and six boys. One student was in year 12 while the remaining students were in year 10 (5 students) or year 9 (3 students). No student identified as an Aboriginal and/or Torres Strait Islander person and only one student spoke a language other than English at home.

The year 12 student was studying biology, chemistry and physics together with maths (at a level of methods, B or similar). Five year 9 and 10 students said that they were 'very likely' to choose STEM subjects in future high school years and two felt they were 'likely' to do so. Only one student was not sure yet whether they would study any STEM subjects in later years.

Most students (7) indicated an interest working in 'professional, scientific and technical services' while three students indicated they hadn't really thought about it yet. Other industries of interest to students for future careers were:

- information, media and telecommunications (3)
- health care and social assistance (2)
- arts and recreation services (1)
- manufacturing (1)
- other services (1 – software engineering).

What level of knowledge did the students have about related careers?

Most students felt they had a high or very high level of knowledge of technology (7), and science (6) related careers.

Whereas students tended to have an average or high knowledge of engineering (8) and maths (6) related careers.

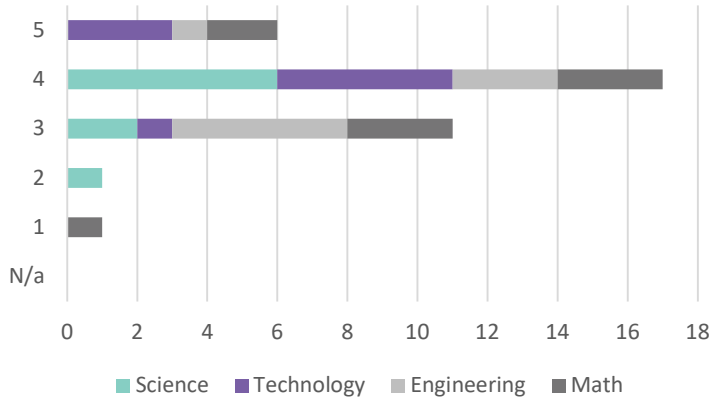

Figure 1: Student knowledge of STEM related careers
Scale: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

How important did students think STEM was to their potential future careers?

Most students thought science (8), technology (7) and maths (8) were of high or very high importance to their future careers. Engineering was of high or very high importance for six students. While two students felt technology was of low importance, and one, engineering.

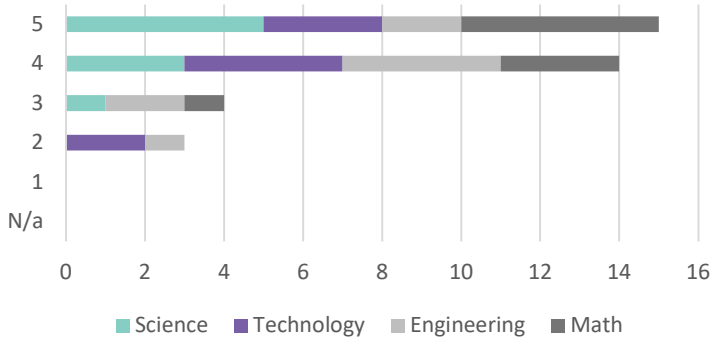

Figure 2: Student knowledge of STEM related careers
Scale: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

How important did students think STEM is to future society?

It was clear that students were united in their view of the importance of STEM to future society.

Between six and eight students rated all STEM areas as being of very high importance to future society. The lowest rating of importance was 'average' with just one student rating average for each of engineering and maths.

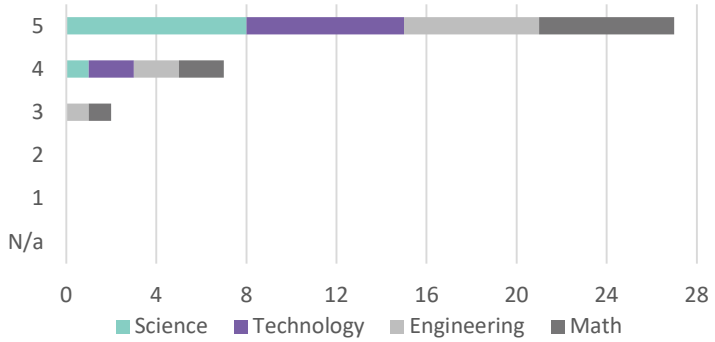

Figure 3: Student relevance to future society
Scale: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

How interested in STEM subjects were the students?

Science, technology and maths were of most interest to the students, with 7 or more students rating these subjects of high or very high interest.

Engineering had lower interest overall and one student who felt it was not applicable to them.

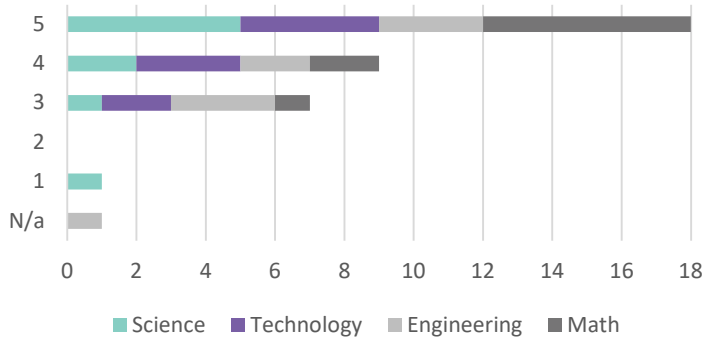

Figure 4: Student interest in STEM subject at school
Scale: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

So, what would make STEM more interesting for students?

Students said STEM would be more interesting if lessons and activities were more practical, fun and hands-on, if they were provided greater content and more challenges (where appropriate), and if there was greater promotion about STEM and how it links to the real world. One student also noted that their interest would likely increase if their results were better. Comments from students included:

- Making it more fun, hands-on, practical and applied lessons and activities

  An increase in hands on, more practical take on STEM subjects would increase my interest. (Student ID 2003010)

  an increase of hands on, practical tasks as well as design and innovation would increase my interest in STEM (Student ID 2003016)

  More problem-solving/design based activities (Student ID 2003014)

  More fun and engaging opportunities. Although I am a beginner programmer, the Cybersecurity challenge run on Grok has allowed me to explore Cybersecurity and the possibilities of it as a job. The challenge has taught me features and modules of Python involved with Cybersecurity and made me solve problems using this knowledge. I think more opportunities like this would increase my interest in STEM subjects further. (Student ID 2003049)

- Providing greater challenges and variety in content

  In technology, I want to be pushed further. In maths, I want to look at pure maths (Student ID 2003011)

  more teachers and schools doing STEM based activities, more robotics teams available to join. (Student ID 2003039)

  A higher diversity of co-curricular STEM based activities e.g.: Drones! (Student ID 2003018)

- Increasing promotion and discussion, including how it links to the real world

  better advertisement and promotion of STEM, (Student ID 2003039)

  More links to potential future careers/more knowledge about (Student ID 2003014)

  Talking about it more, such as advertising it and making so we know more about it and what we can do with it. (Student ID 2003043)

  Another note would be real-world applications. While I enjoy mathematics, I often think to myself "How would I actually use this in the real world? I am not going to find the trajectory of a melon with an equation of $y = x^2 + 10x + 9$". If we could have more opportunities to apply real-world mathematics while learning mathematics, instead of sitting in a classroom for 50 minutes answering questions, I feel more students would have an interest in STEM. (Student ID 2003049)

- Link between interest and improved results

  Possibly if I got better results in them, but that relies on me. (Student ID 2003015)

How satisfied were the students, with their STEM subject grades?

Students were most satisfied with their results in maths, science and technology, with seven of the nine students rating their satisfaction high or very high. For two students, technology results were not applicable, as was the case for engineering for four students.

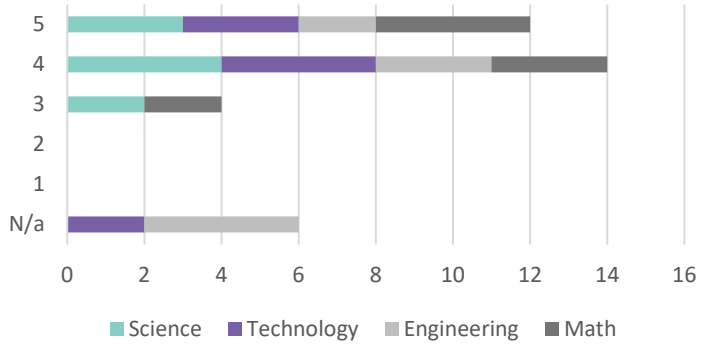

Figure 5: Student satisfaction with STEM subject grades
Scale: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

What did students think would improve their STEM grades?

Students indicated that improvements in their STEM grades would require changes to teacher delivery and content together with greater personal effort and involvement. It was also recognised that this would be more likely to occur if their enjoyment and understanding of STEM was increased. Student comments were:

- Teaching

  For improvement, teaching focus should shift more to STEM based tasks to further my knowledge and capabilities. (Student ID 2003010)

  More lesson time! We need more STEM lessons (Student ID 2003011)

  A little bit of organisation and communication would improve my STEM subjects in the future. (Student ID 2003016)

  probably more attention to your needs and tasks that are suited to your skill set and results (ones that just challenge you enough to increase your skills) giving you more challenging tasks if you can do the easy things, like in Digital tech, I can do all the things assigned to the class but I was never given more challenging tasks to do. (Student ID redacted)

- Personal effort / involvement

  Less mistakes (i.e. reading question wrong), more studying (Student ID 2003014)

  More effort on my part (Student ID 2003018)

  Practicing the STEM subjects and making sure your able to do the following tasks. (Student ID 2003043)

- Enjoyment, interest and understanding

  If I enjoyed the subjects more than I do now and my understanding of them. (Student ID 2003015)

  … I am already achieving extremely high in STEM subjects. This is mainly because I have a personal interest in STEM and wish to pursue a career in STEM. (Student ID redacted)

What would make the students more likely to choose STEM subjects in the future?

Students highlighted that their likelihood of choosing a subject in the future comes from being interested in a subject; having it delivered in a way that is practical, fun and challenging; knowing how it is tied to real-world careers and opportunities; and that the subject is well-resourced and supported financially, where opportunities for national representation exist.

This was evident in student comments such as:

> *Interesting, what I'm passionate about (Student ID 2003014)*
>
> *… A more practical version of STEM would make it more likely for me to choose STEM in the future. (Student ID 2003016)*
>
> *More fun STEM challenges (Student ID 2003039)*
>
> *Making STEM more fun but still the same just done differently. So just the way teachers teach it, making it less stressful and making it so all levels have the same concept. (Student ID 2003043)*
>
> *At the moment I already plan to take two science subjects, two maths subjects and digital technologies because I am already very interested in these areas. However, what has increased my interest in these areas is the robotics program at my school. If more programs or opportunities such as this existed at school, I might have gotten more into programming, science and mathematics sooner. Before 2018, when I joined the robotics team, I had never even thought about a field in technology or engineering. The robotics program has allowed me to explore STEM and find areas, such as programming, that I love. (Student ID redacted)*

- Support and funding

  > *Great facilities (Student ID 2003011)*
  >
  > *… better funding for STEM and grants for teams doing FIRST robotics and going to represent Australia overseas. (Student ID 2003039)*

- Link to future career and real-world relevance

  > *If there was a possibility that I would need maths for a subject. And if my idealistic job changes. (Student ID 2003015)*

What did students think would improve their STEM classes?

Reinforcing themes raised in other questions, students indicated that their STEM classes could be improved by making them more hands on and fun while recognising when students require extra extension and challenge. They highlighted the need to link classes to real world, everyday examples. Interestingly, some comments from students showed that a distinction was seen between individual subjects of science, technology, engineering and maths and specific STEM subjects, whereby STEM subjects need greater promotion, information and support. Student comments included:

- Changing class content and teaching approach

  > *More hands-on (Student ID 2003011)*
  >
  > *Improving on new challenges. For example, if a B grade student finished the following task and wanted a new and harder one, teachers should give it to them. Making fun and helping them to both improve their grade and making them want to do the subject more. (Student ID 2003043)*
  >
  > *… I think having more hands-on or real-world applications for these subjects would be best. This is mainly for mathematics, as my school already does numerous practical experiments in science, programming of robots to complete courses in digital technologies and robotics programs for co-curricular. Mathematics however, is often a "boring" subject for many students, as the monotonous question-answering lessons are all we do. (Student ID 2003049)*

- Incorporating real-world connections

  > *More links with professionals/more opportunity to see what different careers are like (Student ID 2003014)*

Maybe an insight of how the subjects will be used in everyday life would improve STEM classes at my school (Student ID 2003016)

… and also more knowledge as to why STEM helps in the future and how it effects society. (Student ID 2003039)

- More STEM promotion

STEM classes are only recently kicking into gear in our school, so we should have a greater focus on incorporating STEM and informing students. (Student ID 2003010)

Definitely needs more promotion, funding and correct equipment. (Student ID 2003039)

What did students think would make their teachers more effective in teaching STEM?

Students indicated teaching effectiveness would be improved by having teachers that were more passionate, educated and inspiring in their teaching of STEM. The students also recognised the need to better identify individual students' level of learning and be able to adapt content and delivery accordingly. Student comments included:

- Teachers being supported to improve their STEM knowledge and delivery

Teachers should be more educated on the importance of STEM and the way that they teach it. (Student ID 2003010)

Independence and practical experiences would improve the teachers. (Student ID 2003016)

More passion. I find passionate teachers feed my interest into the subject. (Student ID 2003018)

more support for them and more training for teachers (Student ID 2003039)

Having the teachers to have a different attitude towards it, example is instead of them just teaching to teach and instead teach to inspire making us want to do the following subject. (Student ID 2003043)

- Teachers understanding and responding to student ability better

Understanding that some people don't grasp subjects as easily as others (Student ID 2003011)

If they could help the students understand the subjects. (Student ID 2003015)

For me, my STEM teachers are already effective enough, but this could be because I am already extremely interested in STEM. Other students in my classes complain about some of my favourite teachers, so while I find them effective, others may not. This could be due to similar reasons stated earlier, such as a lack of practical activities and hands-on experience in school. (Student ID 2003049)

So, how is the partnership helping students?

What benefits from the STEM partnership did the students see?

According to the students, their teacher's participation in the STEM partnership provided them with improvements in their grades and more general benefits including improved learning and STEM knowledge and skills, and a greater understanding of the importance of STEM in the future and STEM careers.

- Improved student grades

Five of the nine students thought their teacher's participation in the program had impacted their grades due to increased understanding of everyday use, better understanding of subject content making learning easier, increased enjoyment of the subjects and being able to learn how to be more professional.

Comments were:

> *They have provided an insight on how STEM is used in everyday subjects and how it is used. (Student ID 2003016)*
>
> *As a result of this program, my overall knowledge of STEM has increased, naturally this feeds into my academic subjects. (Student ID 2003018)*
>
> *My grades have remained at a constant A+ in Digital tech (I do coding) and I understand coding and programming much better and easier. (Student ID redacted)*
>
> *Yes, they have. Because when someone wants to do something and they actually like it, they'll do better at it more and more. (Student ID 2003043)*
>
> *The [organisation redacted] professional programmers taught me to think and work more like a professional programmer- including efficient systems and computational thinking. I had never programmed anything before starting the robotics program, but when I started taking digital technologies classes, I found I was achieving some of, if not the, highest grades in the class. Having the computational thinking skills taught to me by the [organisation redacted] professionals, even though I was a year behind on digital technologies, I found it easier and more fun than any other subject. (Student ID redacted)*

Two students indicated the partnership did not impact their grades and two preferred not to say.

- Other student benefits

Seven of the nine students believed they had benefited from their teacher's involvement in ways other than their subject grades. These impacts included improved teaching leading to improved learning, improved in knowledge and skills, increased understanding of the importance of STEM in the future and in careers. The other impacts students said they received from their teacher's involvement in the program included:

> *As a result of participating in the program, my teacher is able to apply their knowledge and understanding to teaching, allowing me to learn it. (Student ID 2003010)*
>
> *My understanding as to why STEM is important has increased and I have much more knowledge about it as well (Student ID 2003039)*
>
> *Learned new skills, learnt how they are relevant to professions (Student ID 2003014)*
>
> *They help is in designing aspects, practical work and innovation which has taught me skills for the future (Student ID 2003016)*
>
> *Yes them making me realize how important all the STEM classes are to us in the future has increased a lot more. (Student ID 2003043)*
>
> *Before starting the robotics program, I had never had an interest in programming … they got me interested in the field of computer science. I didn't originally want to be a programmer, but they helped me get started and get to the place I am today, as well as spiking my interest in this field. (Student ID 2003049)*

Only one student did not think they had received any other benefits and one student preferred not to respond.

Did students think their teacher's participation in the program changed their classes?

Three students thought that they had noticed changes in classes taught by the teacher that were beneficial to themselves and other students that were 'most likely due to their teacher's participation in the program'. The impacts and changes that students noted included teachers becoming more knowledgeable, and students having increased fun and interest in subjects, becoming more knowledgeable and finding subjects easier.

This was evident in comments:

- Changes in teacher

  Definitely more knowledgeable tutoring-wise, evaluating and improving processes from a professional viewpoint. (Student ID 2003014)

- Changes in students

  We have a better knowledge of what we are doing and we find things easier to do once they explain everything. (Student ID 2003039)

  Them making it more fun and making us want to do the following subject. Making it a bit more easier but at the same time challenging. (Student ID 2003043)

Students thought the changes were beneficial due to the real-world links, increased confidence in students enabling them to help their peers, and improved teaching ability that resulted in greater student enjoyment in classes. Evident in comments:

Students interested in following different careers can link the skills they are learning now to how they are applied in a professional workplace. (Student ID 2003014)

Because we are more confident in what we do and we can explain what we have been taught to others that have not done it yet. (Student ID 2003039)

… making the teachers get students more, improving their teaching abilities etc. Then with students we are enjoying our classes more and improving them in the process. (Student ID 2003043)

What else did students let us know?

Five students provided additional insights they thought could inform the evaluation, with one advising that they do not participate in STEM outside of the partnership activities.

Student comments reinforced the benefit of the program and the importance of increasing the inclusion of girls, as well as recognising the important role of robotics in the future and calling for greater government support of such initiatives. Comments were:

The program was highly appreciated and hugely beneficial at our school - it would be great to see it continue to happen (Student ID 2003014)

Making an impact on all genders. What I mean by the following is that not that many girls are doing example Digital Tech. Me as an example of this, having a few friends that are doing, there's not many. (Student ID redacted)

We need better attention to robotics and Technology as they will be an essential career in the future and knowledge in these fields will be very valuable and important. Technology is the future of the world and we need more people giving it attention, funding and promotions for all genders, especially girls as I have not seen many girls doing STEM at all, and being a girl, I really want to see more girls doing it. (Student ID redacted)

I feel like STEM is one of the largest, most important and fastest growing areas for students and society. If STEM programs, such as the robotics team I am a part of, was supported more by the government, more opportunities would be available for students to explore and be involved with. (Student ID 2003049)

Students were also asked how the survey could be improved for future use. Two students thought the number of questions could be reduced further by combining similar questions. Student feedback is appreciated and will be considered for future surveys, if conducted.